

REMARKS/ARGUMENTS

This reply is in response to the Office Communication dated May 6, 2009. This amendment amends claims 1, 8, 10 and 19 and adds new claims 20-26, leaving claims 1-13, 15, 16 and 19-26 of which claims 1, 21 and 26 are independent claims.

The office action (1) rejected claims 19 under 35 U.S.C. 112, second paragraph, for failing to particularly point out and distinctly claim the subject matter which the applicant regards as the invention; (2) rejected claims 19 under 35 U.S.C. 101 because the disclosed invention is inoperative and therefore lacks unity; (3) rejected claims 1-3, 6, 9, 12, 15, 16 and 19 under 35 U.S.C. 102(e) as being anticipated by Bosch (U.S. Patent 6,506,254); (4) rejected claim 4 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang (U.S. Patent Publication 2003/0188685), Inazawa (U.S. Patent 5,595,627), Miller (U.S. Patent 4,439,463) and Frankel (U.S. Patent 6,019,848); (5) rejected claims 5 and 7 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Zhao (U.S. Patent 5,885,356); (6) rejected claim 8 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Zhao as applied to claim 5 above, and further in view of Freiburger (U.S. Patent 3,880,396); (7) rejected claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Zhao (U.S. Patent 5,968,379); (8) rejected claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Sonopy (U.S. Patent 6,492,629); (9) rejected claim 11 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Collins (U.S. Patent 6,063,233); (10) rejected claims 1-3, 6, 9, 12, 15, 16 and 19 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang; (11) rejected claim 4 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Inazawa, Miller and Frankel; (12) rejected claims 5 and 7 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Zhao; (13) rejected claim 8 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang and Zhao as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Freiburger; (14) rejected claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Zhao; (15) rejected claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further

in view of Sonopy; (16) rejected claim 11 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Collins.

(1, 2) Regarding the rejection of claim 19 under 35 U.S.C. 112 and 35 U.S.C. 101, applicant has amended the claim. Specifically, applicant has amended claim 19 to provide a limitation that the heater liner does not emit atoms that contaminates a substrate while being processed. Applicant submits that there is no new material added, and supports for the present amendment can be found at least in paragraphs [0019] and [0022], which disclose that contamination atoms are contamination to the substrate.

Contamination is a serious issue in device processing, since any contamination can degrade, render inoperative or make unpredictable behaviors of the devices under processing. For example, copper atoms, if diffused to the channel of a silicon device, can generate midgap states which allow the device to turn on or off at a much lower applied voltage, rendering the device to be highly susceptible to noise.

The present invention relates to plasma processing on silicon substrates, with at least the advantages of reducing contamination and increasing etching efficiency. Thus in an embodiment, contamination atoms are considered as atoms released from the surrounding environment (such as the heater liner) that affect the substrates being processed.

(3) Regarding the rejection of claims 1-3, 6, 9, 12, 15, 16 and 19 under 35 U.S.C. 102(e) as being anticipated by Bosch, applicant has amended the claims to particularly point out the innovative features of the present invention. Specifically, applicant has amended the claims to provide a limitation that the heater liner covers a substantial portion of the leakproof wall that is exposed to the plasma and presents a metal or alloy surface toward the plasma. Applicant submits that there is no new material added, and supports for the present amendment can be found at least in Fig. 2. and paragraphs [0020] and [0053]. As shown in Fig. 2 and discussed in paragraph [0053], the heater liner 14 overlays the inside of a significant portion of the leakproof wall 2 that is in contact with the plasma. The heater liner 14 is made of a metal or alloy, and thus presents a metal or alloy surface toward the plasma.

Applicant submits that the present amended claims are not anticipated by Bosch since Bosch fails to disclose at least an element of the present claims, namely a heater liner presenting a metal or alloy surface toward the plasma.

In an embodiment, the present invention discloses a heater liner for improving efficiency of an etch process, for example, the anisotropic etching of silicon in an alternating method where a sequence of an etch step is alternated with an passivation step. During the pasivation step, a polymer is deposited on the substrate, and also can be deposited on the chamber wall. The deposited polymer on the chamber wall may be outgasing under the effect of plasma processing, contributing to an additional virtual flow of passivation gas, resulting in a thicker passivation layer and subsequently, a longer etch time. Thus in an embodiment, the present invention discloses a metal or alloy heater liner to prevent polymer deposition on the chamber wall, to maintain a consistent etch rate and thus an improvement of process efficiency. In an aspect, the present invention also recognizes that ceramic heater liner is not appropriate, especially for alternating etching method, for example, because of contamination of the substrate and also of reduction in etching efficiency.

Thus in an embodiment, the present invention discloses a metal or alloy heater liner, overlying a substantial portion of the chamber wall that is exposed to the plasma, and presenting a metal or alloy surface toward the plasma. Advantages of the present metal or alloy heater liner includes reduction in substrate contamination and improvement in etching efficiency.

In contrast, Bosch discloses a ceramic plasma liner, shaped and treated to improve particle performance. Bosch is silent with respect to a metal or alloy heater liner, and instead employs ceramic material for reducing metal contamination. Bosch discloses bonding the ceramic tiles to an aluminum backing plate, however, applicant submits that the aluminum backing plate is attached to the backside of the ceramic tiles, and thus Bosch fails to disclose a heater liner presenting a metal or alloy surface toward the plasma.

The examiner stated that Bosch teaches that the heater liner 20 is made of aluminum. Applicant respectfully disagrees. The liner of Bosch comprises an aluminum backing plate, and is made of ceramic. Thus applicant submits that while it might be conceivable to say that Bosch liner 20 comprises aluminum, it is not appropriate to say that the liner is made of aluminum.

Applicant further submits that Bosch teaches away from using an aluminum liner exposing an aluminum surface to a plasma. Bosch teaches that a ceramic liner has an added benefit that it does not contain aluminum and thus reduce aluminum contamination to the processed substrates (Col. 10, lines 47-50).

The examiner stated that Bosch does not teach away from the use of aluminum in the liner. Applicant submits that Bosch recognizes that plasma exposure of an aluminum liner can contribute to aluminum contamination, and thus Bosch teaches that not using aluminum (e.g., in a position that aluminum facing the plasma exposure) could reduce aluminum contamination. Thus applicant submits that Bosch teaches that aluminum liner facing a plasma exposure generate contamination on the processed substrates. Applicant further submits that contamination is a serious issue in semiconductor device processing, and this statement is the equivalent of the recommendation of not using aluminum liner facing a plasma exposure. In other words, applicant submits that Bosch teaches away from using aluminum liner facing the plasma exposure. For aluminum that is not exposed to a plasma, there is no contamination issue, and thus Bosch teaches that aluminum backing plate can be used.

Thus applicant submits that Bosch teaches away from using an aluminum liner exposing an aluminum surface to a plasma to reduce aluminum contamination.

(4) Regarding the rejection of claim 4 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang, Inazawa, Miller and Frankel, applicant submits that the combination of prior art references all fail to disclose a passivation gas source, and a control device to cause the passivation gas source and an etch gas source to operate in alternation.

In an embodiment, the present invention discloses an alternating method for etching silicon, comprising a repeated sequence of etching with a plasma of etching gas and a passivation with a plasma of passivation gas. The etching gas, for example, SF_x , attacks the substrate to etch the substrate. The passivation gas, for example, C_xF_y , coats the substrate with a polymer. The sequential treatment of etching and passivation is the basis of an alternating etching method to etch silicon anisotropically. The invention discloses SF_x and C_xF_y as exemplary etching gas and passivation gas, respectively, but is not restricted to and is not defined by these gases. Applicant submits that, as disclosed by the present specification, a passivation gas is a gas that generates a polymer coating for passivating the substrate surface under the present plasma

exposure. Under this disclosure, applicant submits that the combination of Bosch, Wang, Inazawa, Miller and Frankel fails to disclose a passivation gas source.

The examiner stated that Inazawa discloses a passivation gas source 68 (C₄F₈). Applicant submits that the gas source 68 of C₄F₈ is in fact an etching gas (Col. 6, lines 50-65). Even though the gas 68 of Inazawa is similar to an exemplary passivation gas source of the present claim, applicant submits that it performs different functions and thus cannot be characterized as passivation gas source.

In addition, applicant submits that these prior arts all fail to disclose a control device to cause an etching gas and a passivation gas to operate in alternation. These prior arts provide valves and controls to control these gases individually, but are all silent with respect to operate these gas in cyclic alternation.

(5) Regarding the rejection of claims 5 and 7 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Zhao, applicant submits that these are dependent claims, and thus should be patentable at least by the reasons stated by the independent claim.

(6) Regarding the rejection of claim 8 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Zhao as applied to claim 5 above, and further in view of Freiburger, applicant submits that this is a dependent claim, and thus should be patentable at least by the reasons stated by the independent claim.

(7) Regarding the rejection of claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Zhao, applicant submits that these are dependent claims, and thus should be patentable at least by the reasons stated by the independent claim.

(8) Regarding the rejection of claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Sonopy, applicant submits that these are dependent claims, and thus should be patentable at least by the reasons stated by the independent claim.

(9) Regarding the rejection of claim 11 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Collins, applicant submits that this is a dependent claim, and thus should be patentable at least by the reasons stated by the independent claim.

(10) Regarding the rejection of claims 1-3, 6, 9, 12, 15, 16 and 19 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang, applicant has amended the claims to

particularly point out the innovative features of the present invention. Specifically, applicant has amended the claims to provide a limitation that the heater liner presents a metal or alloy surface toward and substantially surrounding the plasma. Applicant submits that the present amended claims are not obvious in view of Bosch and Wang since Bosch and Wang all fail to disclose at least an element of the present claims, namely a heater liner presenting a metal or alloy surface toward and substantially surrounding the plasma.

In an embodiment, the present invention discloses a heater liner presenting a metal or alloy surface toward the plasma with the metal or alloy surface substantially surrounding the plasma. The surrounding surface can prevent polymer deposition, and the metal or alloy surface can reduce contamination.

In contrast, Bosch discloses a ceramic liner and teaches that exposing an aluminum surface toward a plasma increases the contamination of processed substrates. Wang discloses metal shield 150 to shield components or walls of the chamber from the plasma, but the metal shield is positioned away from the main plasma environment. In fact, the metal shield of Wang cannot surround the plasma since doing so would block the power transfer from the coil 360 to the process chamber. Both Bosch and Wang are silent with respect to a heater liner presenting a metal or alloy surface toward and substantially surrounding the plasma.

Applicant further submits that it would not be obvious to combine the art of Bosch with the art of Wang. Applicant submits that Bosch discloses a ceramic liner surrounding the plasma, and Wang discloses a metal shielding to shield components of the process chamber away from the plasma environment, but there is no suggestion or motivation to combine these arts.

For example, it would not be obvious to apply the surrounding liner of Bosch to the metal shield of Wang, since doing so would prevent the operation of Wang process chamber. Wang discloses an power antenna position outside the process chamber to transfer inward. Using a metal liner would effectively shield this power transfer and render the process chamber non operative. Also, it would not be obvious to use a metal shield of Wang to the ceramic liner of Bosch, since Bosch teaches that metal liner, e.g., aluminum, increases contamination levels in processed substrates, a serious concern in semiconductor processing.

Thus applicant submits that the present claims are patentable in view of Bosch and Wang since both of these prior arts fail to disclose an element of the present claims, namely a heater

liner presenting a metal or alloy surface toward and substantially surrounding the plasma. Further, applicant submits that it would not be obvious to combine the arts of Bosch and Wang, since Bosch teaches that doing so contributes to high level of contamination, and Wang shows that doing so would render his reactor inoperable.

(11) Regarding the rejection of claim 4 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Inazawa, Miller and Frankel, applicant submits that the combination of prior art references all fail to disclose a passivation gas source, and a control device to cause the passivation gas source and an etch gas source to operate in alternation.

As disclosed above, the present passivation gas is disclosed as a gas that under the present process, generates a polymer coating for passivating the substrate surface. And thus, applicant submits that the combination of Bosch, Wang, Inazawa, Miller and Frankel fails to disclose a passivation gas source.

In addition, applicant submits that these prior arts all fail to disclose a control device to cause an etching gas and a passivation gas to operate in alternation. These prior arts provide valves and controls to control these gases individually, but are all silent with respect to operate these gas in alternation.

(12) Regarding the rejection of claims 5 and 7 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Zhao applicant submits that these are dependent claims, and thus should be patentable at least by the reasons stated by the independent claim.

(13) Regarding the rejection of claim 8 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang and Zhao as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Freiburger, applicant submits that this is a dependent claim, and thus should be patentable at least by the reasons stated by the independent claim.

(14) Regarding the rejection of claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Zhao, applicant submits that these are dependent claims, and thus should be patentable at least by the reasons stated by the independent claim.

(15) Regarding the rejection of claims 10 and 13 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Sonopy, applicant submits that these are dependent claims, and thus should be patentable at least by the reasons stated by the independent claim.

(16) Regarding the rejection of claim 11 under 35 U.S.C. 103(a) as being unpatentable over Bosch in view of Wang as applied to claims 1-3, 6, 9, 12, 15, 16 and 19 above, and further in view of Collins, applicant submits that this is a dependent claim, and thus should be patentable at least by the reasons stated by the independent claim.

Applicant further added claims 20-26. Claim 20 discloses that the leakproof wall comprises metal (Paragraph [0047]). Claims 21-25 disclose a metal or alloy heater liner is positioned within a metal leakproof wall of a reactor (Paragraphs [0047], [0053]). Claim 26 discloses a reactor comprising a heater liner and etching/passivating gas sources. Applicant submits that these new claims are also patentable in view of the cited prior art references.

Conclusion

In light of the above, it is respectfully requested that all outstanding rejections be reconsidered and withdrawn. The Examiner is respectfully requested to telephone the undersigned if he can assist in any way in expediting issuance of a patent.

The Commissioner is authorized to charge any underpayment or credit any overpayment to Deposit Account No. 06-1325 for any matter in connection with this reply, including any fee for extension of time, which may be required.

Respectfully submitted,

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